



Licensed Devices General Technical Requirements - Overview

**October 2005
TCB Workshop**

**Steven Dayhoff
Equipment Authorization Branch**

**Federal Communications Commission
Office of Engineering and Technology
Laboratory Division**



Overview

- ☐ General Information
- ☐ TCB Rules Scopes
- ☐ FCC Compliance Testing
- ☐ Scope B1 Personal Mobile Radio Services
- ☐ Scope B2 General Mobile Radio Services
- ☐ Scope B4 Microwave Radio Services



General Information

- ❑ Understanding how FCC rules for licensed equipment are written and how FCC operates
 - The FCC rules are Title 47 of the Code of Federal Regulations
 - Part 2 of the FCC Rules covers general regulations & Filing procedures which apply to all other rule parts
 - Technical standards for licensed equipment are found in the various radio service rule parts (e.g. Part 22, Part 24, Part 25, Part 80, and Part 90, etc.)
 - All material covered in this training is either in these rules or based on these rules



General Information

- ❑ FCC TCB process divides all Licensed Radio Service Rules into four scopes of authorization.
- ❑ Not all equipment which is approved by the FCC may be approved by a TCB
 - New technology must be approved by the FCC
 - Technology where there is no developed test procedure must be approved by the FCC
 - Equipment which requires RF exposure evaluation may be approved only if the Exclusion list requirements are met and the TCB has attended the proper training



TCB Radio Service Rules Scopes

- ❑ Scope B1- Personal mobile radio Services
 - 47 CFR Parts 22(cellular),24,25,27
- ❑ Scope B2- General mobile radio services
 - 47 CFR Parts 22(non-cellular),73,74,90,95,& 97
- ❑ Scope B3- Maritime & Aviation Radio Services
 - 47 CFR Parts 80 & 87
- ❑ Scope B4- Microwave Radio Services
 - 47 CFR Parts 27,74, & 101



FCC Compliance Testing

❑ 47 CFR Parts 2.1046 - 2.1055 Tests required for all Licensed Devices.

- 2.1046 - RF power output
- 2.1047 - Modulation Characteristics
- 2.1049 - Occupied Bandwidth
- 2.1051 - Conducted Spurious Emissions
- 2.1053 - Radiated Spurious Emissions
- 2.1055 - Frequency Stability
 - » Temperature
 - » Voltage



47 CFR Parts 2.1046 - 2.1055

- ☐ These tests are generally required for all licensed devices
- ☐ In some case the Radio Service Rules will have special or unique requirements which will add additional tests to be performed
- ☐ FCC recognizes ANSI/TIA/EIA 603-2003 as a document generally suitable to meet the minimum testing requirements in these sections



2.1046 - RF Power Output

- ☐ Form 731 Power always listed in Watts
- ☐ For units with antenna connector power is always conducted measurement
- ☐ For units with built-in/integral antenna power is measured as Effective Radiated Power (ERP) unless otherwise specified
 - Example of exception is Part 24 PCS 1900 MHz band where Effective Isotropic Radiated Power is required
- ☐ Power listed on grant-normally mean power
 - Example of exception- Single sideband transmitters require peak envelope power and RADAR transmitters are peak values

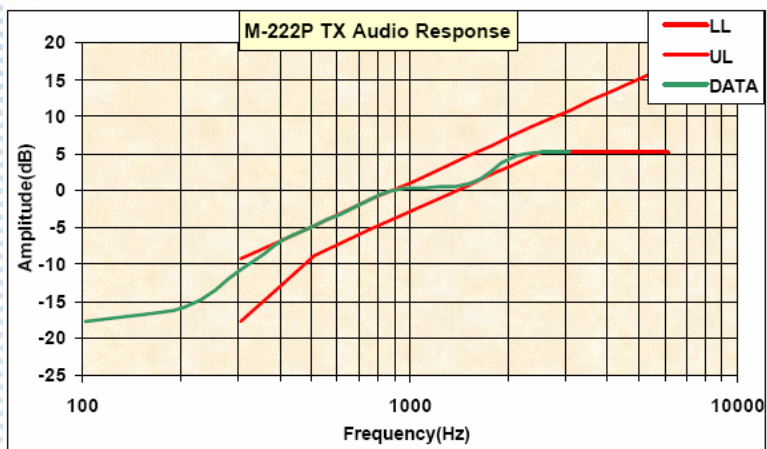


2.1047 (a) Frequency Response

- ❑ For voice modulated equipment a frequency response plot over the range 100 - 5000 Hz should be provided
 - EIA/TIA 603 shows a different range but since the FCC rules are specific, the above range should be shown
- ❑ For units with extended audio frequency response (wireless microphones) the response should be measured up to 15 KHz since up to 15KHz can be used in typical broadcast operation



Audio Frequency Response Plot



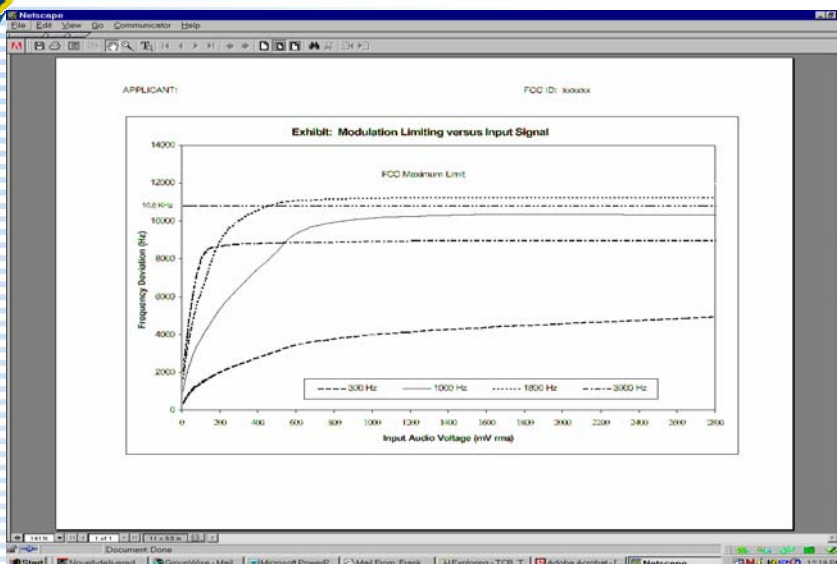


2.1047 (b) Modulation Limiting

- ❑ A plot of modulation level (%) as a function of increasing modulation input
 - A “family” of curves should be provided. Most test procedures for typical radio telephone use recommend the frequencies of 300, 1000, and 3000 Hz be used. These are acceptable but 2500 Hz audio frequency is also recommended since this is the frequency normally used in the occupied bandwidth test
 - The audio input level should be increased to at least the level used for the occupied bandwidth test.
 - Do not follow the 603 document for this test as it doesn't provide the required information.



Modulation Limiting Plot



October, 2005

TCB Workshop



2.1049 Occupied Bandwidth

- ❑ Occupied BW is the portion of the spectrum which contains 99% of the emitted energy (.5% of the remaining is above and .5% is below the occupied BW)
 - The FCC uses these test results to compare the modulated spectrum with the emissions masks in the various radio service rule parts
 - The occupied bandwidth may not exceed the authorized bandwidth in the radio service rules
 - The occupied bandwidth test should be performed for each type of emission listed on the grant



2.1049 Occupied Bandwidth

- ☐ The emissions mask is normally applied with the Zero dB level equal to the level of the unmodulated carrier or equivalent composite power level
- ☐ The test results are also used to confirm the modulation level used for the occupied BW test
- ☐ In some cases the Radio Service Rules specify a spectrum analyzer resolution bandwidth setting
- ☐ The proper emissions “mask” from each Radio Service Rule part must be applied to the spectrum display



Bandwidth Terminology

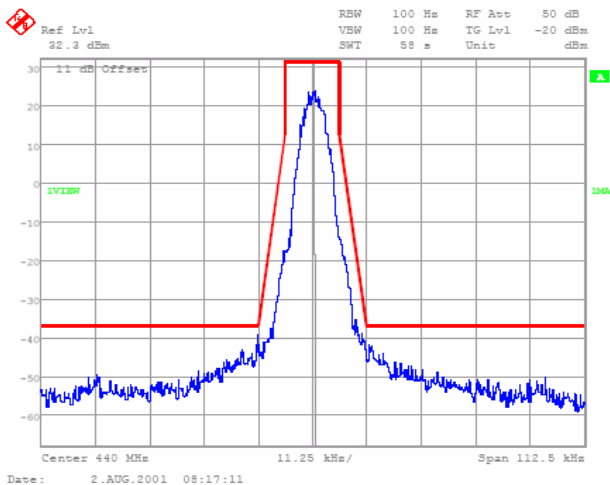
- ☐ Authorized Bandwidth
 - The maximum bandwidth the specific radio service rule section allows

- ☐ Necessary Bandwidth
 - The maximum bandwidth a specific device requires to operate in the devices worst case mode

- ☐ Occupied Bandwidth
 - The bandwidth of a specific device at a specific time



EMISSION MASK PLOT



measured with normal Test modulation : Pseudo random data stream max. 8kBit/s

LIMITS SUBCLAUSE § 90.210

Emission Mask D - 12.5 kHz channel bandwidth

October, 2005

TCB Workshop

16



2.1051 Conducted Spurious

☐ Measurements of the emissions at the antenna terminal

- This test is to determine emissions conducted through the antenna terminal. If the device doesn't have an antenna connector the data is obtained at the base of the antenna terminal
- The highest frequency measured is specified in 2.1057 of the rules
- The emission limits specified are an extension of the occupied bandwidth limits which are listed in the radio service rules measured up to the highest frequency specified in 2.1057



2.1053 Radiated Spurious

- ❑ This test is to determine emissions radiated from the cabinet, chassis, and associated wiring
 - The emission limits specified are an extension of the occupied bandwidth limits which are listed in the radio service rules measured up to the highest frequency specified in 2.1057
 - Use Signal Substitution method described in EIA 603
 - All emission radiated relative to a half wave dipole
 - Power should be referenced to a dipole antenna
 - Method used because it standardizes the process and eliminates measurement uncertainties due to site characteristics, attenuation and path loss



2.1055(a) Frequency Stability

□ Frequency Stability versus Temperature

- Test is normally performed from -30 to +50 degrees centigrade
- Data is normally provided in 10 degree C increments
- Some radio service rules specify different frequency ranges. When more specific requirements are listed, the more specific requirements should be followed
 - Example - Some Part 80 Maritime rules specify -20 to +50 degrees centigrade
 - Example - Some Part 73 Broadcast Service rules specify 0 to 50 degrees centigrade
- EIA/TIA 603 has less detail than the FCC rules and should not be followed for 2.1055 tests



2.1055(d) Frequency Stability

☐ Frequency Stability versus Voltage

- For AC powered equipment the primary supply voltage should be from 85 to 115 % of the nominal value
 - If the equipment has an automatic shutoff before it gets to these levels, the device should be tested to the shutoff point
- For battery operated equipment the stability should be tested to the battery endpoint specified by the manufacturer
- EIA/TIA 603 has less detail than the FCC rules and should not be followed for 2.1055 tests



Test Procedures

- ☐ FCC Rules and Regulations
 - FCC e-mail service for publications and notices.
subscribe@info.fcc.gov
- ☐ EIA/TIA 603-2003
 - FM Land Mobile Transmitter Test Methods
- ☐ EIA/TIA TSB102.CAAA
 - Digital transceiver measurements
- ☐ ANSI C63.4 -2001
- ☐ Other industry accepted test procedures
 - Many test procedures available from Global Engineering Documents - <http://global.ihs.com> 800-854-7179 or 303-397-7956



Scope B1 Personal Mobile Radio Services

☐ Personal Mobile Radio Service Scope B1 includes:

- Part 22 - Cellular Radiotelephone Service
- Part 24 - Personal Communications Service (PCS)
- Part 25 - Satellite Communications
- Part 27 – Misc. Wireless Communications Service (MWCS)



Part 22 H Cellular Radio Service

☐ Operating Frequency Bands:

- Mobile 824-849 MHz
- Base Station 869-894 MHz

☐ General Technical Requirements:

- 22.355 - Frequency Stability
- 22.913 - Power Output (ERP)
- 22.915 - Modulation requirements
- 22.917 - Emissions Limits
 - (f) emission in base station band requirements



Part 22 H Common Cellular Modes

- ☐ AMP - American mobile phone standard (voice)
- ☐ SAT - Supervisory Audio Tone
- ☐ ST - Signaling Tone
- ☐ Wideband Data
- ☐ CDPD - Cellular digital packet data
- ☐ NAMPS - Narrowband American Mobile Phone Standard
- ☐ CDMA - Code division multiple access
- ☐ TDMA (DQPSK) - Time division multiple access
- ☐ GSM - Global Mobile System



Part 22 H Cellular Emission Designators

- ☐ 40K0F8W - Cellular voice & signaling tone
- ☐ 40K0F1D - Cellular wideband data
- ☐ 1M25F9W - CDMA
- ☐ 30K0DXW - North American digital cellular - TDMA
- ☐ 30K0GXW - GSM
- ☐ 28K0FXW - CDPD



Part 24 E - Broadband PCS

- ❑ Operating Frequency Bands:
 - Blocks from 1850 - 1990 MHz

- ❑ General Technical Requirements:
 - 24.232 - Power Output (EIRP)
 - 24.235 - Frequency Stability
 - 24.238 - Emission Limits

- ❑ Special requirements
 - MPE or SAR evaluation required for portable and mobile units per 2.1091 & 2.1093
 - SAR value(s) listed on grant



Part 24 PCS Emission Designators

- ❑ 1M25F9W – CDMA
- ❑ 4M20F9W – WCDMA
- ❑ 30K0DXW – TDMA
- ❑ 300KGXW – GSM
- ❑ 300KG7W - EDGE



Part 25 Satellite Communication

- ☐ Operating Frequency Bands:
 - 1610 - 1626.5 MHz Up-link
 - 149 - 149.9 MHz & 399.9 - 400.05 MHz (non-voice)

- ☐ General Technical Requirements:
 - 25.204 - Power Output (EIRP)
 - 2.1055 - Frequency Stability
 - 25.216 - Emission Limits

- ☐ Special Requirements
 - Units need ITU GMPCS - MoU Registry
 - Power output for units with built in antennas is listed as EIRP on the Grant



Part 25 Satellite Communication

☐ Special Requirements (continued)

- MPE or SAR evaluation required for portable and mobile units per 2.1091 & 2.1093
- SAR measured value listed on grant

☐ Part 25 Recent Rulemakings

- FCC 02-134 – GMPCS MoU– Global Mobile Personal Communications by Satellite Memorandum of Understanding
 - Establishes GPS band emissions limits for mobile and portable earth stations



Part 27 Wireless Communication

- ☐ Misc. Wireless Communications Service (MWCS)
- ☐ Operating Frequency Bands:
 - 746 - 794 MHz and 2305 - 2360 MHz
- ☐ General Technical Requirements:
 - 27.50 Power Output (EIRP)
 - 27.53 Emission Limits
 - 27.54 Frequency Stability
- ☐ Special Requirements:
 - MPE or SAR evaluation required for portable and mobile units per 2.1091 & 2.1093
 - SAR measured values listed on Grant



Scope B2 General Mobile Radio Services

☐ General Mobile Radio and Broadcast Services Scope B2 Includes:

- Part 22 Non Cellular Services
- Part 73 Broadcast Services
- Part 74 Auxiliary Broadcast Service
- Part 90 Private Land Mobile Radio Service



Part 22 - Non Cellular Services

❑ Operating Frequency Bands

- Subpart E
 - Paging: 152 - 159 MHz, 454 - 459 MHz.
 - Point to Point: 72 - 76 MHz, 488 - 494 MHz
- Subpart F
 - Rural Radio 152 - 158 MHz, 454 - 460 MHz
 - BETRS 816 - 821 MHz, 861 - 866 MHz
 - Basic exchange telephone radio system
- Subpart G
 - Air to Ground 454 - 460 MHz



Part 22 - Non Cellular Services

- ❑ General Technical Requirements Subpart C
 - 22.355 Frequency Tolerance
 - 22.357 Emission Types
 - 22.359 Emission Masks

- ❑ Technical Requirements Subpart G Air to Ground Service
 - 22.809 Power Output
 - 22.861 Emission Limitations
 - 22.863 Frequency Tolerance



Part 73 Broadcast Services

- ❑ AM Stereo Transmitters & Exciters
 - Operating Frequency Bands
 - 0.54 - 1.6 MHz
 - General Technical Requirements
 - 73.44 - AM Transmission System Emission Limitations
 - 73.128 - AM Stereophonic Broadcasting
 - 73.1545(a) - Carrier Frequency Departure Tolerances



Part 74 Auxiliary Broadcast

❑ Operating Frequency Bands

- Subpart D - Remote Pickup 450 - 456 MHz
- Subpart E - Aural Broadcast Auxiliary 944 - 952 MHz
 - Studio Transmitter Link - STL
- Subpart G - Low Power TV, TV Translator and Booster
 - VHF (Channels 2-13) 54-216 MHz
 - UHF (Channels 14-69 (except 37)) 470-806 MHz
 - Channel 37 608-614 MHz
- Subpart H - Low Power Auxiliary Stations
 - 26.1-26.48, 54-72, 161.625-161.775, 174-216, 450-451, 455-456, 470-608, 614-806, 944-952 MHz.
- Subpart L FM Translators & Boosters 88-108 MHz



Part 74 Auxiliary Broadcast

□ General Technical Requirements

- Subpart D - Remote Pickup
 - 74.461 Power Limitations
 - 74.462 Emission & Bandwidth
 - 74.464 Frequency Tolerance
- Subpart E - Aural Broadcast Auxiliary
 - 74.534 Power Limitations
 - 74.535 Emission & Bandwidth
 - 74.561 Frequency Tolerance
- Subpart G - LPTV, TV Translator & TV Booster
 - 74.733 - UHF Translator signal boosters
 - 74.735 - Power limitations



Part 74 Auxiliary Broadcast

- Subpart G (continued)
 - 74.736 - Emission & Bandwidth
 - 74.750 - Transmission System Facilities
 - 74.761 - Frequency Tolerance
- Subpart H - Low Power Auxiliary Stations
 - 74.861 - Technical Requirements
- Subpart L - FM Translators & Boosters
 - 74.1234 - Unattended Operation
 - 74.1235 - Power Limitations & Antenna Systems
 - 74.1236 - Emission & Bandwidth
 - 74.1250 - Transmitters & Associated Equipment
 - 74.1261 - Frequency Tolerance



Part 90 Private Land Mobile

❑ Operating Frequency Bands 1.6 - 940 MHz

- Special Operating Frequency Bands:
 - 173.075 MHz Lo-Jack - 90.20(e)(6)
 - 764-806 MHz - Public Safety Interoperability
 - 902-928 MHz Subpart M, Location & Monitoring
 - 1427-1435 MHz - 90.259 (Public Safety Pool)
 - 2450-2500 MHz – Non-channelized frequencies
 - 3650-3700 MHz – Wireless Broadband Service
 - 4940-4990 MHz – Public Safety
 - 8400-8500 MHz - Subpart Q, Developmental



Part 90 Private Land Mobile

□ General Technical Requirements

- Subpart I - General
 - 90.205 - Power Limitations
 - 90.207 - Types of Emissions
 - 90.209 - Bandwidth Limitations
 - 90.210 - Emissions Masks
 - 90.211 - Modulation Requirements
 - 90.212 - Scrambling Devices & Digital Voice Modulation
 - 90.213 - Frequency Stability
 - 90.214 - Transient Frequency Behavior



Part 90 Private Land Mobile

☐ Special Technical Requirements

- Subpart F - Radio-location Service
 - 90.103 - Technical Standards
- Subpart J - Non voice & other specialized operations
 - 90.241 - Radio Call Box Operation
 - 90.242 - Travelers Information Stations
 - 90.259 - Telemetry
- Subpart K - Special Frequency Bands
 - 90.265(b) - Wireless Microphones for Business uses.



Part 90 Private Land Mobile

❑ Special Technical Requirements

- Subpart R – Public Safety Interoperability
 - 90.531 – Interoperability Channels Operation
 - 90.535 – Spectrum Efficiency Requirement
 - 90.543 – Adjacent Channel Power
 - 90.548 – P25 Interoperability Standards
- Subpart S - SMR Operation
 - 90.669 - Emission Limit for 896-901/935-940 MHz
 - 90.691 - Emission Mask for 806-821/851-866 MHz
 - 2.1091,93 – SAR/MPE Required



Part 90 Private Land Mobile

❑ Special Technical Requirements

- Subpart Y – Public Safety
 - 90.1213 – Channel Band Plan
 - 90.1217 – RF Exposure Requirement
- Subpart Z – Wireless Broadband Service
 - 90.1307 - licensed on the basis of non-exclusive nationwide licenses
 - 90.1319 - 3650–3700 MHz band must employ a contention-based protocol (based on 90.7)
 - 90.1321 - Power and antenna limits
 - 90.1323 - Emission limits

Contention-based protocol. A protocol that allows multiple users to share the same spectrum by defining the events that must occur when two or more transmitters attempt to simultaneously access the same channel and establishing rules by which a transmitter provides reasonable opportunities for other transmitters to operate. Such a protocol may consist of procedures for initiating new transmissions, procedures for determining the state of the channel (available or unavailable), and procedures for managing retransmissions in the event of a busy channel.



Scope B4 Microwave Radio Services

☐ Microwave Radio Services Scope B4 includes:

- Part 27 – Misc. Wireless Communications
 - Broadband Radio Service (BRS)
 - Educational Broadband Service (EBS)
- Part 74 – Program Distribution Services
 - Television Broadcast Auxiliary Service
- Part 101 - Fixed Microwave Services
 - Digital Electronic Message Service
 - Local TV Transmission Service
 - Local Multipoint Distribution Service



Part 27 Subpart M – Broadband Radio Service (BRS)

- ❑ Part 27 Subpart M - BRS
 - ❑ Operating Frequency Band:
 - 2150 - 2168 MHz
 - ❑ General Technical Requirements:
 - 27.54 - Frequency Tolerance
 - 27.50 - Transmitter Power
 - 27.53 - Emissions and Bandwidth
 - 27.1220 - Transmission Standards
 - 27.50 - Signal Booster Stations



Part 27 Subpart M - Educational Broadband Service (EBS)

- ❑ Part 27 Subpart M – EBS
 - ❑ Operating Frequency Band:
 - 2500 - 2686 MHz
 - ❑ General Technical Requirements:
 - 27.50 - Power Limitations
 - 27.53 - Emissions & Bandwidth
 - 27.54 - Frequency Tolerance
 - 27.1220 – Transmission Standards
 - 27.50 - Signal Booster Stations



Part 74 Subpart F - Television Broadcast Auxiliary

☐ Operating Frequency Bands:

- 1990 - 2483.5 MHz
- 6875 - 7125 MHz
- 12700 - 13250 MHz

☐ General Technical Requirements:

- 74.636 - Power Limitations
- 74.637 - Emissions & Emission Limitations
- 74.661 - Frequency Tolerance
- 74.663 - Modulation Limits



Part 101 Subpart C-General Technical Standards

☐ Operating Frequency Band

- 928 - 960 MHz (101.101, 101.147)

☐ General Technical Requirements

- 101.107 - Frequency Tolerance
- 101.109 - Bandwidth (Authorized)
- 101.111 - Emission Limitations
- 101.113 - Transmitter Power Limitations
- 101.131 - Transmitter Construction



Part 101 Subpart G - Digital Electronic Message Service

- ☐ Operating Frequency Band
 - 18870 - 19260 MHz (101.505 & 101.147)
- ☐ General Technical Standards
 - 101.507 - Frequency Stability
 - 101.513 - Transmitter Power (see 101.113)
 - 101.515 - Emissions & Bandwidth (see 101.109 & 101.111)
- ☐ Special Requirements
 - 101.141 - Microwave modulation (minimum data rate)



Part 101 Subpart J - Local Television Transmission Service

☐ Operating Frequency Band

- 6425 - 6525 MHz
- 11700 - 12200 MHz
- 13200 - 13250 MHz
- 14200 - 14400 MHz
- 21200 - 22000 MHz
- 22000 - 23000 MHz
- 31000 - 31300 MHz



Part 101 Subpart J - Local Television Transmission Service

☐ General Technical Requirements

- 101.107 - Frequency Tolerance
- 101.807 - Transmitter Power
- 101.809 - Bandwidth & Emission Limitations (also see 101.109 & 101.111)
- 101.811 - Modulation Requirements

☐ Special Requirements

- 101.141 - Microwave Modulation (minimum data rate)



Part 101 Subpart L - Local Multi-point Distribution Service (LMDS)

☐ Operating Frequency Bands(101.1005)

- 27500 - 28350 MHz
- 29100 - 29250 MHz
- 31075 - 31225 MHz
- 31225 - 31300 MHz

☐ General Technical Requirements

- 101.107 - Frequency Tolerance
- 101.109 - Authorized Bandwidth
- 101.111 - Emission Limitations
- 101.113 - Transmitter Power Limitations



Part 101 Subpart L - Local Multi-point Distribution Service (LMDS)

❑ Special Requirements

- 101.113(c)(1) Spectral Power Density specification.
- Automatic Transmitter Power Control (ATPC) guidelines are contained in TIA TSB 10.
- Authorized bandwidth values shown in Section 101.109 are the same as the assigned frequency blocks so that the emissions mask is applied on the basis of the total band.



Questions and Answers

Thanks!

October, 2005

TCB Workshop

53